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Drainage and Improvement of White Land and Similar Wet Land

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Drainage and Improvement of White Land and Similar Wet Land

By

W. L. POWERS

Drainage is the first step in the improvement of over one million acres, or almost one-third of the Willamette Valley floor land. There is scarcely a quarter section in the valley floor, outdoors, that would not be benefitted by some tile lines. To study this problem an experimental tile drainage system was installed at the Oregon Agricultural Experiment Station in 1914 on a white land field west of the stadium. The system was planned after a

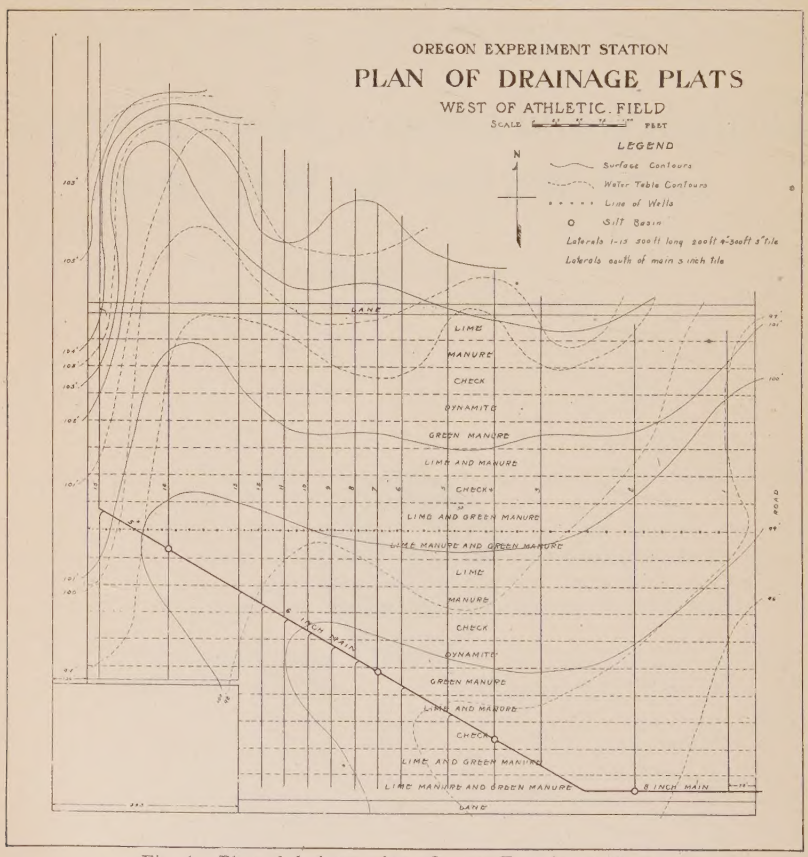

Fig. 1. Plan of drainage plots, Oregon Experiment Station.

study of older existing tile systems on the College farm and throughout the valley. This field is being maintained as a phase of Oregon Soil Investigations to learn the most effective means of improving white land after tiling.

The tiling is arranged at different distances apart, and studies have been made of the outflow, water table conditions, and crop yields as affected by drainage.

The value of lime, manure, rotation, and fertilizers for improvement of the land along with drainage is under observation. The treatments are shown in Fig. 1.

Properties of White Land. Physical analyses of representative samples of white land (Dayton silty clay loam) from the drainage experiment field show that the surface soil contains about 21 percent clay and over 55 percent of silt. In other words, it is a gray silty clay loam. The subsurface is blue clay, containing over 33 percent clay; the subsoil is yellow silt loam, containing only 17 percent clay. Just below the blue clay, or at a depth of about 3 feet, is a friable streak, more porous than the subsoil at greater depth. It is in this friable layer just below the blue clay that it is usually best to place laterals or collecting drains. This condition and the placement of tile are shown by the accompanying sketch, Fig. 2.

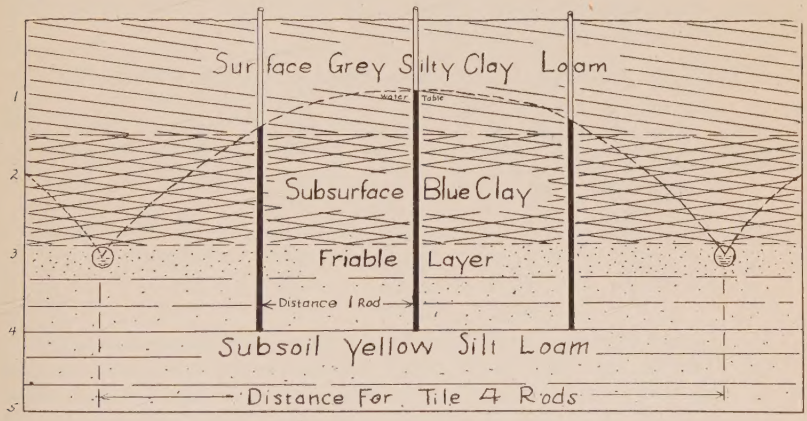

Fig. 2. Condition and placement of tile.

TABLE I. PHYSICAL COMPOSITION OF WHITE LAND FROM DRAINAGE PLOTS

Soil sample	*Total sand*	*Silt*	*Clay*
	%	%	%
Surface gray silty clay loam	15.66	63.73	19.86
Subsurface blue clay	23.46	44.39	33.64
Subsoil yellow silt loam	22.66	58.79	17.45

How Deep Should Tile Be? The tiles should be located in the friable streak below the blue clay and should go over, under, or around thick impervious layers. In typical white land the impervious blue clay extends to about three feet from the surface and the friable streak underneath it will be at about this depth. Some white land has a thicker layer of the impervious clay. Numerous deep borings with a post hole auger or soil auger will show how impervious the soil is, and at what depth and distance apart the laterals should be placed.

Tile Draw Two Rods. In typical white lands tile lines will need to be about 4 rods apart to provide good drainage for field crops.

Experiments show that twenty-four hours after a heavy storm the water table is lowered to a distance of 2 rods on each side of a tile line. In half-white land (Amity silty clay loam) the tile drains may be placed 3½ feet deep and 5 rods apart. This is the gray brown soil that is intermediate between the naturally drained brown soil in the valley and the flat gray land. Advantage should be taken of high spots to omit a lateral here or there, and to use intercepting drains across the base of higher slopes to protect low, flat lands from excess water. A random or natural system of drains can be used where there is a good proportion of brown, naturally drained soil.

Size and Grade. The size of tile depends upon the grade. The greater the fall the smaller the tile needed. In most white lands a fall of two-tenths of a foot to the hundred feet can be secured for lateral drains, and one to two-tenths of a foot per hundred feet for main drains. This is the minimum grade desirable. The more fall the better, up to several feet per hundred. In a fall of two-tenths of a foot in a hundred a 5-inch tile will remove a half inch of rainfall per acre and serve as an outlet for about 12 acres; a six-inch tile about 20 acres; an eight-inch, 35 acres; ten-inch, 65 acres; and a twelve-inch tile, 100 acres.

TABLE II. DISCHARGE FROM LATERALS PLACED DIFFERENT DISTANCES APART. WINTER 1915-16.

Distance between laterals	*Maximum discharge in acre in. an acre in 24 hrs.*	*Mean discharge in acre in. an acre in 24 hrs.*	*Mean daily rain previous 2 days*	*Daily outflow*	*Tile per acre*	*Mean acre in. discharge per 1000 ft. tile in 24 hrs.*
ft.			*in.*	*%*	*ft.*	
25	1.20	.48	0.60	80	1742	.96
50	1.35	.55	0.60	92	872	1.10
75	.80	.33	0.60	55	586	.66
100	.90	.32	0.60	53	436	.64

Tile Should Handle a Half Inch Rain a Day. Drainage measurements (Table II) show that in heavy weather a good tile system should remove a half inch of rain an acre each twenty-four hours. During unusual storm periods as much as an inch an acre per day has been measured going out from the experimental tile system. From 50 to 80 percent of the rainfall passed through the soil and out through the tile. Seventy-three percent has passed through 4 foot columns of this soil in experimental drainage bins of concrete. Except for periods of heavy weather of four or five days' duration, the drainage is not apt to exceed a third of an inch to the acre. It is recommended that tile mains have capacity to handle a half inch up to 40 acres in area, and a third inch to the acre for larger areas. The number of acres that tile of different sizes will serve is shown by Table III.

TABLE III. CAPACITY OF MAIN DRAINS (1000 FEET IN LENGTH)
(Acres drained of ½-inch rainfall per 24-hour day by tile of different sizes.)

	Fall in feet for each 100 feet					
Tile diameter	0.05	0.10	0.2	0.3	0.4	5.0
	5/8 in.	1 3-16 in.	2⅜ in.	3⅝ in.	4¾ in.	6 in.
	Acres of land drained					
5	8.8	9.9	11.7	13.3	15.0	16.0
6	14.0	15.6	18.5	21.0	23.2	25.2
8	28.6	32.0	37.8	42.9	47.5	51.6
10	50.0	55.6	65.8	74.6	82.6	89.6
12	76.1	87.4	103.4	117.2	129.6	140.9

Does Drainage Pay? Drainage in experimental fields studied has doubled the yield. Before drainage the crop yield was so low that profit was uncertain. The larger crop has insured a good profit. Following drainage in 1915 when winter barley drowned out in part on untiled land that yielded 12 to 15 bushels an acre, the yield of tiled land at different spaces ran as high as 33¾ bushels for the closest spacing as follows:

EFFECT OF DRAINAGE ON YIELD

Distance between laterals	*Yield of barley per acre in 1915*
ft.	*bu.*
25	33.73
50	29.90
75	27.90
100	20 to 35
Undrained	15

Seven bushels of beans bought tile for an acre.

A piece of white land in the irrigation field south of the railroad on the College farm was tiled in 1921. This area had previously been abandoned to pasture. The first crop following drainage was white beans. The yield without fertilizer was 11 bushels of beans, which sold for $3.00 a bushel. The tile lines are 5 rods apart. The material or tile cost at this spacing was $20.00 an acre. The tiling was installed by students as class work but would have cost $20.00 an acre to install had the work been paid for. Seven bushels of beans returned the money paid out for the tile, as the beans sold at $3.00 a bushel.

Those who have tried it say that it pays to tile white land. Timely drainage pays in increased yields and increased land values. It is the most permanent improvement that can be put upon land. Every acre of our white land can be tiled, and it will pay a better rate of interest on the total investment when drained than it pays undrained.

Improvement of White Lands. The drainage experiment field is divided into approximately half-acre plots, and treated with different applications following drainage to build up the soil. Analysis of the white land shows that it contained the following amounts of plant food in the top 6⅔ inches of soil at the time it was drained.

CHEMICAL ANALYSIS OF WHITE LAND

Plant food element	*Pounds in 2,000,000 (6⅔ in.)*
Nitrogen	2,000
Phosphorus	1,311
Calcium	28,200
Magnesium	4,400
Potassium	36,178
Sulfur	560

These lands are distinctly acid. They contain an almost inexhaustible supply of potash, provided it is liberated in amount needed by plants. The supply of phosphorus and sulfur is below average. The supply of nitrogen is scarcely average, due to the ground being too wet in winter and too dry in summer, and unfavorable for legumes before drainage.

Lime and Manure Made a Ton More Clover. The first stand of clover was secured in 1920 on the drained white land field. In 1921 the first cutting of clover yielded as shown in the accompanying table.

YIELDS FROM DIFFERENT TREATMENTS, DRAINAGE FIELD 1921

Plot	*Treatment*	*Clover hay yield, tons per acre*
1	Untreated	2.000
2	Limed	2.447
3	Manure	2.715
4	Green manure	2.042
5	Untreated	2.017
6	Lime and manure	2.731
7	Gypsum* and green manure	2,000
8	Lime, manure and green manure	2.900

*Late appplication.

In this experiment lime made nearly half a ton increase, while lime and manure made nearly a ton increase. In 1922, the second crop year of clover, yields were slightly less on account of the dry season, and the quality was reduced on account of more foul growth. The hay in 1921 was of excellent quality.

Lime and Manure Aid Drainage. The drainage of white land is difficult because of the impervious soil structure. Use of lime and manure following drainage has helped improve the tilth, has increased capacity for usable water, and has aided removal of the excess of water by drainage.

TABLE IV. INCHES MONTHLY RAINFALL AND PERCOLATION.
Drainage Bins 3½ x 3⅓ x 4 feet deep. Oregon Experiment Station

Month 1922-23	*Rainfall*	*Percolation*			
		White land untreated	*Dayton limed*	*Gray Silty manured*	*Clay Loam limed and manured*
	in.	*in.*	*in.*	*in.*	*in.*
October	4.88	.75	.98	1.16	.93
November	3.07	3.12	3.37	3.19	3.38
December	11.11	10.93	11.02	12.04	11.44
January	10.88	8.53	9.05	10.20	8.92
February	2.16	1.65	1.41	1.78	1.60
March	2.57	1.68	1.61	1.41	1.43
April	2.71	.63	.85	.78	.72
Total	37.38	27.29	28.29	30.62	28.42
Percent outflow		73.00	76.00	82.00	76.00

Fertilizer Experiment. The white land south of the railroad in the corner of the irrigation field is utilized for fertilizer experiments. The field was in corn in 1920. In 1921 winter grain drowned out. Tiling was then extended through the center of the plot. In 1922 the field was in white beans. This year (1923) it is in winter barley, which has not drowned out, and is the first successful winter grain crop on this land. The yield for the corn and beans from different treatments is given in Table V.

Phosphorus and Manure Did Best. The maximum yields the past year were secured where manure at the rate of 10 tons and superphosphate 250 tons an acre were applied. The gain was 3⅓ bushels, worth $10.00 an acre. Lime or fertilizers will be more effective following drainage.

Crops for Drained White Land. Vetch is a suitable first crop and may be followed with winter grain, seeding down to clover, with lime disked

in after plowing. One and one-half tons an acre is not too much for an initial application of lime. One ton each rotation thereafter may be sufficient. Grain, clover, and some row crop, seeding the clover down one or two years, according to the stand, should, with a little manuring, maintain the organic matter and nitrogen content of this land. To keep up the mineral plant food, sulfur or gypsum may be applied to the young clover, and superphosphate to the cultivated crop. One hundred pounds with manure or 200 pounds an acre without manure is a suitable application of superphosphate.

TABLE V. FERTILITY EXPERIMENT ON "WHITE LAND"

Corvallis field south of railroad.

Tenth-acre plots	*Treatment*	*Rate per A.*	*Yield per acre*			
			Corn, 1920		*White beans, 1922*	
			No Lime	*Lime*	*No Lime*	*Lime*
			T.	*T.*	*bu.*	*bu.*
1	None		3.50	4.16	8.7	11.3
2	Superphosphate	250 lbs.	4.80	4.85	10.7	11.7
3	Land-plaster	100 lbs.	4.90	4.35	11.0	11.0
4	None		3.90	4.90	11.3	11.0
5	Nitrate	150 lbs.	3.95	4.10	11.7	10.7
6	Manure	10 T.	4.90	5.75	12.3	12.3
7	None		4.60	3.94	12.0	10.7
8	Manure and superphosphates	10 T. & 250 lbs.	4.40	4.45	14.6	13.0
9	Manure and Rock Phosphate	10 T. & 500 lb.s	3.90	4.19	12.3	12.0
10	None		4.30	3.75	11.3	11.3
Average of unfertilized plots—1, 4, 7, and 10			4.07	4.37	10.2	10.8

1921 Winter barley partly drowned out.

Tiling completed in spring of 1921. Retreated 1922.

South half of all plots is limed. 1½ tons lime per acre showed slight gain in yield with corn, and better color; appearance also improved, but not average yield of beans. Beans sold at $3.00 per bushel.

Feasibility Surveys. A general feasibility survey has been made in cooperation with the United States Office of Drainage Investigations to tie together former surveys of various white land prairies, and develop a comprehensive plan for the main outlet ditches needed for the valley. A general map has been prepared, the yardage for the different ditches calculated, and it is found that there are about 200,000 acres in large areas that will require outlet ditches. The average cost of these, including such projects as the Amazon, the Muddy, Dayton Prairie, French Prairie, and Ankeny Bottom will not exceed $10.00 an acre.

Community Ditches. The outlet ditches on small community projects may frequently be started with the large road grader or Steel-V, and in some cases where running water is at hand they may be, in part, sluiced out. They can then be dressed and finished with teams and scrapers and by hand.

Drainage Districts. Drainage district law provides a modern, practical means of cooperation for the purpose of securing district outlet ditches. We have 54 such drainage districts in the state. The assessments are in proportion to benefits, so that every man gets a square deal, and pays in proportion to the drainage he gets. The cost of drainage may be distributed over a period of years, during which time the increased crops provide the money for drainage tax.

The Farmer should study subsoil and ground water conditions in wet areas, then view out a full system of drains by the aid of a level, if necessary. The system may be installed in units, most necessary parts first, but it is best to order tile in car lots. The farmer should make a study of drainage so that he can superintend and inspect his own work. He should sketch the tile lines installed and note results, extending the system as needed.

The Community needing an outlet ditch should secure preliminary topographic and soil surveys to learn the costs, feasibility, and extent of the proposed outlet system. If feasible a petition for a drainage district should be prepared according to the state law and presented to the county court. The district officers then secure plans and estimates, and the county court appoints viewers or assessors, the district officers secure bids, let the contract, and superintend the construction.